An Evaluation of the Status of the Coney, *Cephalopholis fulva*, Population in Bermuda

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ABSTRACT

The decline in landings of commercially important grouper species in Bermuda (i.e. *Epinephelus guttatus*, *E. striatus*, *Mycteroperca bonaci*, *M. interstitialis*, *M. tigris* and *M. venenosa*) from 1975 to 1981 has been well documented. This decline led to an increase in landings of smaller grouper species, most notably coney (*Cephalopholis fulva*) and Creole fish (*Paranthias furcifer*). In this study, coney landings (1975—2004) and size-frequency data (1990 - 1994 pooled data & 2001) were analyzed and mortality estimates were generated from length-converted catch curve analysis in order to gain insights into the effect of fishing on the *C. fulva* population around Bermuda. From 1975 to 1985, reported coney landings did not exceed 10,000 kg. However, in 1986, landings rose sharply to over 20,000 kg. While reported landings did not indicate substantial increases in catches of coney since 1986, mortality estimates suggested that fishing pressure had increased on the population since that time. Results show an almost seamless effort shift from fish pots to handlines following a 1990 fish pot ban. The total mortality rate (Z) calculated from data, pooled from sampling during 1990 - 1994 (0.13), was half that calculated from data collected in 2001 (0.26). A shift to smaller size classes from the 1990 - 1994 period to 2001 was also observed. This further suggested an increase in fishing pressure during this period. As landings statistics are only submitted by commercial fishermen, increased mortality could be the result of increased coney catches by a large, virtually unregulated recreational line-fishing sector.

KEY WORDS: Coney, *Cephalopholis fulva*, mortality rate, fishery landings

Evaluación del Estado de la Cherna Cabrilla, *Cephalopholis fulva*, Población en Bermuda

En el presente trabajo queda bien documentada la disminución de diferentes especies de mero en Bermuda en el período comprendido entre 1975 y 1981. Dicha disminución conllevó a un aumento de desembarques de pequeñas especies de mero. En el presente estudio se analizan los desembarques de la cherna cabrilla (1975 - 2004) y los datos sobre la regularidad de la talla (datos combinados desde 1990 al 1994 y 2001), así como los estimados de mortalidad generados a partir del método de captura en talla para ganar una mayor visión del efecto que representa la pesca en la población de *C. fulva* alrededor de Bermudas. Desde el año 1975 a 1985, los desembarques de cherna cabrilla reportados no excedieron los 10 mil Kg. Sin embargo, en 1986, las cifras de desembarques aumentaron abruptamente alcanzando la cifra de 20 kg. En tanto los desembarques reportados no indicaron los aumentos sustanciales en las capturas desde 1986, los estimados de mortalidad sugerían que la presión pesquera había aumentado en dicha población desde aquella fecha. Los resultados muestran un desplazamiento del esfuerzo casi continuo desde las nasas hasta las líneas de mano siguiendo la restricción de pesca en embalses que data del año 1990. También se observó un desplazamiento hacia clases de menores tamaños a partir del periodo de 1990 - 1994 al 2001. Ello sugirió un aumento en la presión pesquera durante dicho periodo. Debido a que las estadísticas de embarque son solo presentadas por los pescadores comerciales, el aumento de la mortalidad podría ser el resultado del incremento de la captura de la cherna cabrilla por un inmenso sector dedicado a la pesca deportiva no regulada.

PALABRAS CLAVES: Cherna cabrilla, *Cephalopholis fulva*, tasa mortalidad, desembarques de la pesqueria

INTRODUCTION

In 1975, data acquired from a self-reporting statistical programme (see Frick *et al*. 1989) indicated that epinepheline groupers comprised almost 50% of the total weight of food fish landed in Bermuda. From 1975 to 1981, landings of all of the commercially important grouper species in Bermuda (*Epinephelus guttatus, E. striatus*, *Mycteroperca bonaci*, *M. interstitialis, M. tigris* and *M. venenosa*) suffered dramatic declines and by 1989, groupers comprised only about 20% of the total landed weight of food fish (Bannerot *et al*. 1987, Luckhurst 1996, Luckhurst and Ward 1996). The decline in large grouper species led to an increase in landings of smaller grouper species such as the coney and Creole fish (*Paranthias furcifer*) (Luckhurst 1996).

While many management measures have been implemented in Bermuda to afford protection to grouper species (1990 fish pot ban, bag limits, minimum legal sizes and seasonally closed areas), the effectiveness of these measures still needs to be ascertained. Moreover, effective fisheries management is hindered by the lack of sufficient data on the status of fish stocks and their response to fishing pressure (Kura *et al*. 2004). This is especially true of reef fish species such as groupers as attempts at management and stock assessments are fairly recent (Huntsman *et al*. 1999). Not surprisingly then, despite the increasing importance of small grouper species (particularly the coney) in fish catches in Bermuda and many locations in the Caribbean (Beets *et al*. 1994, Luckhurst 1996, Jiménez and Fernández 2001, Reynal *et al*. 2004), very little is known about the biology and stock status of many of these species. Fishery assessments of *C. fulva* were made in St. Croix, U.S. Virgin Islands by Beets *et al*. (1994) and Cummings *et al.* (1997) with both studies documenting significant declines of the species. In Bermuda, the coney has been a dominant component of grouper landings since 1991 (Luckhurst 1996). However, no fisheries assessments have been carried out on this species in Bermuda. This paper examines the status of the coney population around Bermuda using landings data and knowledge of the life history of the species (see Trott 2006).

MATERIALS AND METHODS

Landings data were extracted from historical records and the Bermuda Fisheries Statistical Database. Historical perspectives of the operation of the Bermuda fishery and reporting practices over the years were also taken into consideration when interpreting landings figures.

Estimates of instantaneous total mortality (Z) were obtained for two time periods, 1990 - 1994 and 2001, from length-converted catch curve analysis using the FiSAT package (FAO 2002). This method of estimating Z is widely used but assumes continuous recruitment (which is generally not true for grouper species) (Appledorn 1996). In an attempt to approximate the assumption of continuous recruitment, samples for the first time period (1990 - 1994) were pooled from several years and, for 2001, were collected from throughout the year (see Appledorn 1996)

Coney size data used in catch curve analysis were collected by hook-and-line. No age and growth data were available for the 1990 - 1994 data set and , as a result, the input growth parameters required for the catch curve analysis were obtained from the age and growth data in Trott (2006), i.e. $L\infty$ = 283.89 mm FL; K = 0.18; t_0 = -2.102. The assumption is that there was no change in these parameters between the two time periods. Sizes from the 1990 - 1994 and 2001 samples were also used in size-frequency analysis.

Hewitt and Hoenig's formula (2005) [$M = 4.22/t_{max}^{0.982}$] was used to estimate the natural mortality of coney in Bermuda (t_{max} = 28 years for coney). Following calculations of natural mortality, fishing mortality rates were calculated using the formula $F = Z–M$ and exploitation rates were calculated using the formula $E = F/Z$ (Gulland 1983).

RESULTS

Landing Statistics

Since the fish pot ban of 1990, *C. fulva* has dominated the grouper landings (Figures 1 and 2). Catches of coney (by weight) were consistently higher than all other grouper species and represented almost 50% of the total combined grouper landings from 1990 to 2004. Figure 1 shows the percentage of coney landings compared to landings of other grouper species for years 1975, 1989, 1991 and 2004 (graphs for 1975 and 1989 were redrawn from data in Luckhurst and Ward (1996)). In 1975, coney made up a very small percentage of grouper landings at just over 3%. However, by 1989 (one year before the fish pot ban), coney landings represented over 20% of total grouper landings (Figure 1). The proportion of coney landings increased further in the year after the pot ban (1991) when almost 50% of total grouper landings were made up of coney (Figure 1). Although there was a decline in coney landings and in the percentage of overall grouper catch in the last two years (2003, 2004) (Figure 2 and 3), coney still provided a substantial proportion of grouper landings in Bermuda. It should be noted that overall grouper landings declined 83% between 1975 and 2004, due primarily to large scale declines in the larger species which were heavily fished mainly at spawning aggregations (Luckhurst 1996).

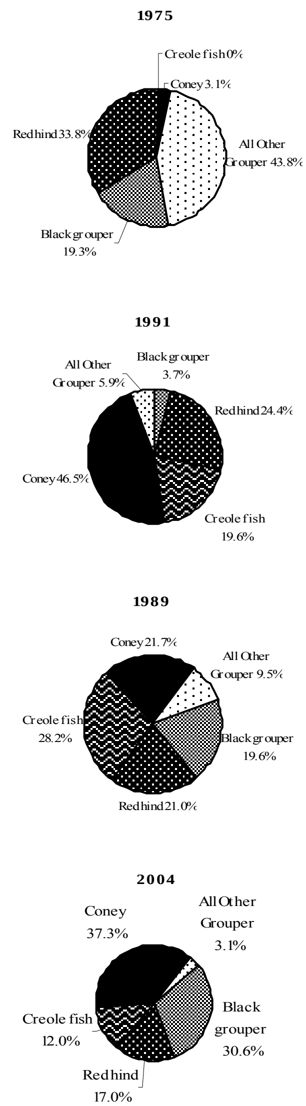

Figure 1. Grouper catch composition pre-1990 pot ban (1975 & 1989) and post-1990 pot ban (1991 & 2004) illustrating coney landings in comparison to other grouper species landings.

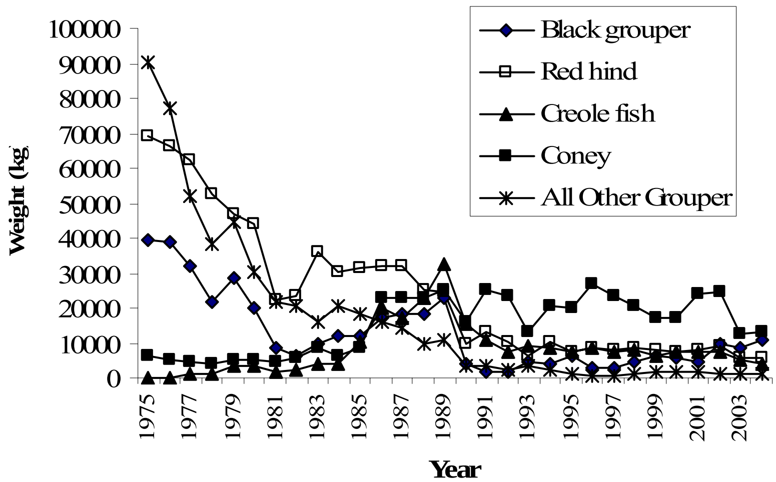

Figure 2. Landings of selected grouper species from the Bermuda commercial fishery from 1975 to 2004

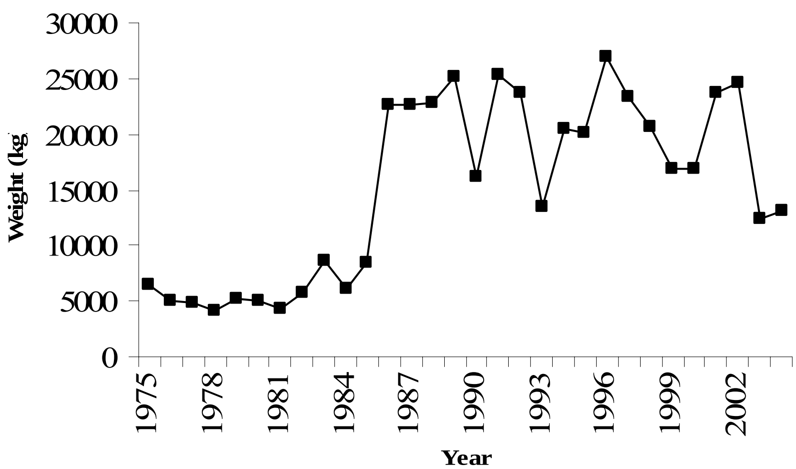

Figure 3. Coney landings reported from the Bermuda commercial fishery from 1975 to 2004

From 1975 to 2004, reported landings of coney ranged from 4,065 kg to 26,937 kg (Figures 2 and 3). Landings remained fairly stable from 1975 to 1985 but increased dramatically in 1986 (from 8,477 kg in 1985 to 22,628 kg in 1986). From 1986 to 2002, landings were largely above 20,000 kg but fluctuated considerably with large declines in catch occurring in 1990 and 1993. The highest landings (26,937 kg) were recorded in 1996 and a steady decline from that year led to catches around 17,000 kg in 1999 and 2000. Landings increased again to around 24,000 kg in 2001. In 2003, landings fell to their lowest point since 1986 with only 12,462 kg of coney reported and landings rose only slightly in 2004.

MORTALITY

The estimates of instantaneous total mortality (Z) for the two time periods, 1990 - 1994 and 2001, obtained for *Cephalopholis fulva* in Bermuda from catch curve analysis, were 0.13 and 0.26, respectively. This indicated a significant increase in total mortality between the two time periods. The estimate of coney natural mortality derived from Hewitt and Hoenig's (2005) formula was 0.16. This estimate was greater than the estimate of total mortality calculated for the 1990 - 1994 time period, thus suggesting that $M \approx Z$. For the 2001 period, a fishing mortality rate (F) of 0.10 was calculated. The exploitation rate (E) for coney in Bermuda for the 2001 period was therefore 0.38.

FREQUENCY DISTRIBUTIONS

A shift to smaller size classes was evident when comparing size frequency data from the 1990 - 1994 and 2001 data sets (Figure 4). Analysis of mean lengths between these two periods showed a significant difference (ANOVA, df = 1, 742; F = 114.711, p = <0.0001; 1990 - 1994 (n = 314), 2001 (n = 430)). Mean length for coney in 1990 - 1994 was 272 mm FL while the mean length for coney in 2001 was 245 mm FL. Modal size in 1990 - 1994 was the 270-279 mm FL size class while in 2001 it was 230-239 mm FL.

DISCUSSION

Catch statistics collected from commercial fishermen show a dramatic increase in *C. fulva* landings from 1985 to 1986. Luckhurst (1996) attributed much of this increase to technological advancements in the fish pot fishery. However, some of this increase is most likely due to an anomaly in reporting practices. Because of the coney's small size, only the largest fish were marketed whole, therefore, a large proportion of landed coneys were filleted (Norbert Simmons, Marine Resources Division, Pers. communication). For a number of years, a fillet category was included on the catch statistics reporting form. This category was discontinued in 1986 due to the realisation that it did not facilitate the reporting of many of the smaller fish species (Frick *et al.* 1989). It is most probable that a sizable proportion of the coney catch before 1986 was reported in this fillet category. As a result, some of the observed increase in landings in 1986 was likely due to this shift in reporting practices.

From 1986, coney landings have varied without an overall trend. This probably reflects changes in fishing effort over the years. Nonetheless, the results demonstrate an almost seamless effort shift from fish pots to handlines following the 1990 fish pot ban. While catch levels dropped in 1990, the high catchability of coney by handlines was evidenced by the resurgence in 1991 of reported coney landings to pre-pot ban levels (see detailed analysis by gear type in Luckhurst, 1996).

CPUE data, which are used as a proxy for abundance (Appledorn 1996), were not available for the coney fishery as fishing effort is recorded in gross measure (hours at sea). Thus the decrease observed in coney landings and catch composition in 2003 cannot be attributed with confidence to a decrease in coney abundance. Anecdotal evidence suggests that this decrease could actually have more to do with a shift in fishing effort for a more lucrative species, the black grouper (*M. bonaci*). In 2002, fishermen introduced a new trolling method specifically for capturing black grouper. This resulted in landings of this species almost doubling from 2001 to 2002. It is therefore quite probable that the drop in coney landings and composition of catch in the last few years can be largely attributed to this shift in fishing effort to the larger and highly prized black grouper.

While the commercial fishery landings data did not indicate any major changes post pot ban in coney availability in Bermuda, it was evident from the catch curve analysis that total mortality (Z) had increased. This increase in mortality appears to be due to an increase in fishing mortality (F). However, it was difficult to determine the magnitude of the increase in F as the estimate of M was greater than the estimate of Z obtained for the 1990-1994 time period. The estimate of M for coney in Bermuda was similar to estimates for large grouper species with comparable life spans (Huntsman *et al*. 1999). This appears reasonable as other small grouper species are more short-lived (Craig *et al*. 1999, Potts and Manooch 1999) suggesting that there is lower natural mortality on the coney population in Bermuda compared with other small grouper species.

The situation observed for the 1990 - 1994 period, where $M \approx Z$, implied that coney were only lightly exploited during this period and was perhaps a similar situation to that observed for gag (*Mycteroperca microlepis*) in the early 1970s from the U.S. South Atlantic Bight (Huntsman *et al*. 1999). The increase in exploitation may be attributed in part to an increase in recreational fishing landings. As *C. fulva* are readily caught on handlines, anecdotal information suggests that the coney has been increasingly targeted by recreational fishermen over the years. However, there are no data to substantiate this as statistics are not currently collected from recreational fishermen.

Another indication of increased fishing pressure on the coney population in Bermuda was the large decline in coney mean length from 272 mm FL in 1990 - 1994 to 245 mm FL in 2001. Coney in Bermuda are protogynous hermaphrodites (Smith 1959, Trott 2006) and interpretation of this decline in size, without accompanying information on sex ratio and size-at-transition (along with size-at-age) for the 1990 - 1994 data set is difficult and its significance is unclear. However, this position is supported by the observed decrease in the average size of coney concurrent with increasing fishing pressure over a six year period in St. Croix, U.S. Virgin Islands (Beets *et al.* 1994). A study on protogynous parrotfishes in the Caribbean also documented declines in the mean size of most species with increasing fishing pressure (Hawkins and Roberts 2003).

A slightly female-biased sex ratio (1.15F:1M) was observed for coney in Bermuda (Trott 2006). This implies that fishing has had little effect on the coney sex ratio. Coleman *et al*. (1996) suggest that the effect of fishing on the male:female sex ratio varies among grouper species due to differences in the mechanisms and timing of sex change. In species such as gag and scamp (*M. phenax*), where males and females do not co-occur outside of spawning time, the sex change initiation is temporally and spatially restricted. In these species, males are often selectively fished (as they are usually the largest fish), thus the male:female sex ratio can be substantially reduced.

However, coney do not aggregate to spawn (Colin *et al*. 1987, Sadovy *et al*. 1994), and sex change is not time restricted [as is indicated by the occurrence of transitionals in every month of the year (Trott 2006)]. In this case, it is not expected that sex ratios would change appreciably with fishing pressure (Coleman *et al*. 1996). However, a male bias was observed during the summer spawning period (Trott 2006) so it appears that the behaviour of coney could allow for selectivity of males during this time. This could lead to sperm limitation and subsequent reproductive failure of the population if fishing effort is sufficiently high (Bannerot *et al.* 1987, Huntsman and Schaaf 1994, Huntsman *et al.* 1999).

Nonetheless, the *C. fulva* population in Bermuda appears to have been fairly resilient to the fishing pressure exerted upon it. This is evidenced by the reasonably stable fishery landings and large proportion of individuals in the population 10 years of age and older (Trott 2006). Several factors seem to have contributed to this resilience:

i) The size of recruitment to the local handline fishery, which is larger than the size at first sexual maturity (Trott 2006), and probably allows a large proportion of fish to spawn at least once before being captured;
ii) Apparent socially-mediated sex change where information is not temporally or spatially limited thus the sex ratio can be maintained by the sex change of females when the male of a social unit is removed (Coleman *et al.* 1999);
iii) The higher abundance of coney due to the reduction in interspecific competition or predation caused by the overfishing of many of the larger grouper species (Chiappone *et al*. 2000, Chan and Sadovy 2002); and
iv) The relatively low fishing pressure due to a preference by the fishery for the remaining large grouper species.

Despite the apparent health of the coney population in Bermuda, there are still many threats to preserving this and other grouper species around the island. One of the biggest threats is the large, virtually unregulated recreational fishing sector. Recreational fishermen are not required to report catch statistics and therefore the amount of fish captured by this segment is unknown. This makes it difficult to properly assess the status of fish populations in Bermuda and therefore effectively manage them.

Coleman *et al*. (2000) contend that in order to sustain a species with a long life-span and low natural mortality rate, as suspected in coney and other grouper species, only a small proportion of the population should be removed each year. They suggest that fishing mortality be kept at or near natural mortality for most groupers. The estimate of fishing mortality obtained for coney in this study (0.10) suggests that the population is still being fished below natural mortality levels (0.16). A moderate level of exploitation is also suggested by the exploitation rate calculated (0.38) as an exploitation rate above 0.5 is considered excessive (Gulland 1983). However, as there is evidence that the rate of exploitation has increased substantially over the years, the coney fishery must be carefully monitored and conservative management measures put in place to sustain this population if it is considered necessary. No-take marine reserves may be a viable fisheries management tool to aid in the conservation of all grouper species in Bermuda and may act as an "insurance policy against future fisheries management failures and against overfishing" (Russ 2002). Coney, in particular, appear to be an excellent candidate for protection in even small marine reserves as their home range is relatively small (Trott 2006) and would therefore be better contained in the reserve than more widely-ranging species (Kramer and Chapman 1999).

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